International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM 2018 vol.18 N6.1, pages 67-74

Application of silica nanoparticles for improving abrasion resistance of transparent polyacrylate coatings

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Abstract

Aqueous-dispersion acrylate compositions with different contents of silica nanoparticles (NP) were prepared, which allowed to obtain top transparent coatings with improved abrasion resistance. The nanoscale silica used in the work was obtained by a gas-phase method using high-frequency induction discharge (HFI) in the air atmosphere. The average size of silica nanoparticles measured by transmission electron microscopy (TEM) and laser scattering was 23.5 nm. TEM photos of silica nanoparticles showed that silica was composed of a set of spherical nanoparticles and their aggregates. According to X-ray structural analysis, silica nanoparticles used in the work are an amorphous type of silicon dioxide. Prior to mixing the acrylic dispersions with silica nanoparticles, an aqueous sol was prepared, in which the sodium salt of polyacrylic acid was used as a stabilizer. The required amount of a stabilizing additive was determined by zeta potential values. Grafting of aminopropyltriethoxysilane (APTES) onto the surface of the silica nanoparticles contributed to the increased interfacial interaction between an inorganic nanoparticle and the polymer matrix and, consequently, to the improvement of the physical and mechanical properties of the coatings. To enhance the modifying effect, the treatment of the nanoparticles with silane was performed, ultrasonic dispersion being used. The resulting nanostructured polyacrylate coatings have significantly improved properties compared to non-filled coatings, such as hardness and abrasion resistance. However, the silica content in acrylic compositions is limited due to the deterioration of the formed coatings transparency, and the gloss in the investigated concentration range remains higher than the gloss of polyacrylate coatings containing no nanoparticles. Thus, high-performance characteristics of polyacrylate coatings are achieved when the content of SiO2 nanoparticles equals 1-3 wt %.

http://dx.doi.org/10.5593/sgem2018/6.1/S24.010

Keywords

Abrasion resistance, Coatings, Nanoparticles, Silica, Waterborne acrylate

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